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Board of Agriculture in India

PROCEEDINGS

OF THE

Second Meeting of Agricultural Chemists and Bacteriologists

*Held at Pusa on the 7th February 1921
and following days*

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FROM

S. MILLIGAN, Esq., M.A., B.Sc.,

Agricultural Adviser to the Government of India,

TO

THE SECRETARY TO THE GOVERNMENT OF INDIA,
DEPARTMENT OF REVENUE AND AGRICULTURE,

SIMLA.

Camp Simla, the 13th May 1921.

SIR,

I have the honour to submit the Proceedings of the Second Meeting of Agricultural Chemists and Bacteriologists held at Pusa on the 7th February, 1921, and following days. These proceedings have been recorded by Dr. J. Sen, Supernumerary Agricultural Chemist.

I have the honour to be,

SIR,

Your most obedient servant,

S. MILLIGAN,

Agricultural Adviser to the Government of India.

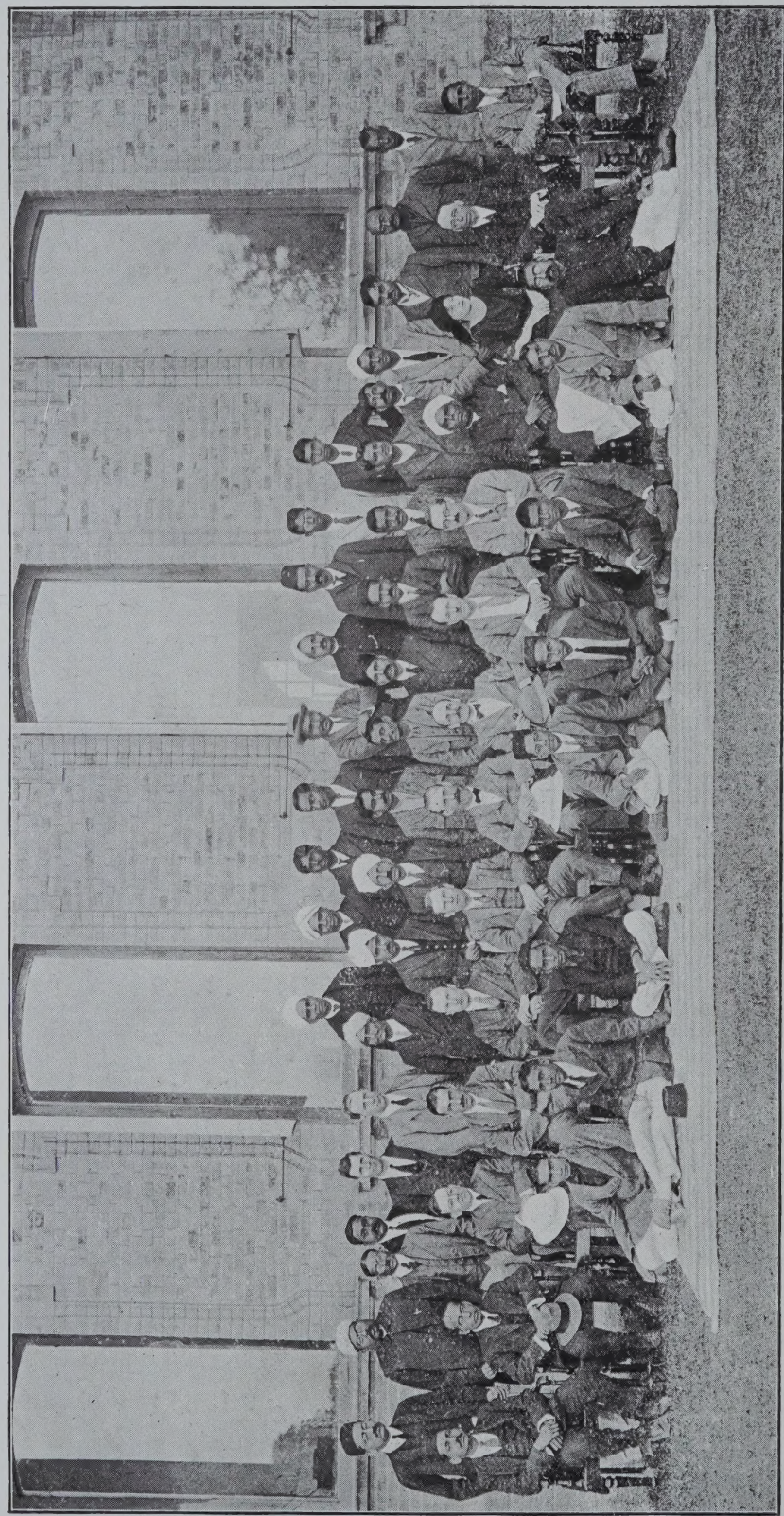
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SECOND MEETING OF AGRICULTURAL CHEMISTS AND BACTERIOLOGISTS, 1921.



Fourth row.

K. P. Pūlai, A. R. P. Iyer, S. C. Biswas, S. C. Dutt, H. D. Singh, K. K. Rao, B. M. Amin, B. C. Das Gupta, N. C. Das Gupta.

Third row.

D. L. Sahasrabudhe, J. Sen, C. V. Sane, A. C. Ukil, C. R. Harler, F. J. Plymen, D. V. Bal, Mukundlal, Ranji Narain, G. B. Pal, P. B. Sanyal, J. N. Mukerji, N. V. Joshi, S. G. Matkekar, S. Das, B. Sen, B. Viswanath, H. D. Sen, N. C. Basu, K. S. Viswanatham.

Second row.

V. A. Tamhane, B. N. Iyengar, R. L. Pendleton, M. Carbery, P. E. Lander, B. H. Wilsdon, W. A. Davis, F. J. Warth, C. S. Taylor, J. H. Walton, M. R. R. Sivan, (Mrs.) D. Norris, R. V. Norris, T. M. Singh.

First row.

S. N. Das Gupta, N. N. Ghosh, A. V. Iyer, N. V. Kanitkar, N. K. Iyer, C. S. R. Iyer, A. K. Mitra, U. Sen Gupta.

THE SECOND MEETING OF AGRICULTURAL CHEMISTS AND BACTERIOLOGISTS.

Introductory.

The Second Meeting of Agricultural Chemists and Bacteriologists was held at Pusa on the 7th February, 1921, and following days.

MEMBERS.

The following members were present :—

1. F. J. Warth, M.Sc., Offg. Imperial Agricultural Chemist. (President for Chemical Subjects.)
2. J. Sen, M.A., Ph.D., Supernumerary Agricultural Chemist. (Secretary.)
3. J. H. Walton, M.A., B.Sc., Offg. Imperial Agricultural Bacteriologist. (President for Bacteriological Subjects.)
4. W. A. Davis, B.Sc., A.C.G.I., Indigo Research Chemist.
5. Roland V. Norris, D.Sc., Government Agricultural Chemist, Madras.
6. Mrs. D. Norris, M.A., Government Agricultural Bacteriologist, Madras.
7. Rao Saheb M. R. Ramaswami Sivan, B.A., Assistant Agricultural Chemist, Madras.
8. B. Viswanath, Assistant to the Government Agricultural Chemist, Madras.
9. K. Krishnamurti Rao, D.Ag., Chemical Assistant to the Government Sugarcane Expert, Madras.
10. C. Somers Taylor, B.A., Agricultural Chemist to the Government of Bihar and Orissa.
11. M. Carbery, B.Sc., Agricultural Chemist to the Government of Bengal.
12. G. B. Pal, M.Sc., Assistant to the Agricultural Chemist to the Government of Bengal.
13. N. C. Basu, M.Sc., Assistant to the Fibre Expert to the Government of Bengal.
14. F. J. Plymen, A.C.G.I., Agricultural Chemist to the Government of the Central Provinces.
15. A. R. Padmanabha Iyer, B.A., Assistant to the Agricultural Chemist to the Government of the Central Provinces.

16. D. V. Bal, L.Ag., Assistant to the Agricultural Chemist to the Government of the Central Provinces.
17. B. H. Wilsdon, M.A., Agricultural Chemist to the Government of the Punjab.
18. P. E. Lander, Ph.D., Deputy Director of Agriculture, Punjab.
19. Ramji Narain, D.Sc., Assistant to the Agricultural Chemist to the Government of the Punjab.
20. L. Mukand Lal, L.Ag., Agricultural Assistant to the Agricultural Chemist to the Government of the Punjab.
21. Thakur Mahadeo Singh, Ph.D., Assistant Agricultural Chemist to the Government of the United Provinces.
22. H. D. Sen, M.Sc., Assistant to the Opium Research Chemist, United Provinces.
23. H. D. Singh, B.Sc., Assistant to the Opium Research Chemist, United Provinces.
24. D. L. Sahasrabudhe, B.Sc., L.Ag., Acting Agricultural Chemist to the Government of Bombay.
25. N. V. Kanitkar, B.Ag., Assistant Professor of Chemistry, Poona.
26. S. G. Mutkekar, Assistant Professor of Bacteriology, Poona.
27. V. A. Tamhane, M.Sc., L.Ag., Soil Physicist to the Government of Bombay.
28. B. Narasimha Iyengar, B.A., Ph.D., Agricultural Chemist, Mysore.
29. C. V. Sane, B. Ag., M.Sc., Director of Agriculture, Baroda.
30. R. L. Pendleton, Ph.D., Director of Agriculture, Gwalior.
31. K. Parameswaran Pillai, B.A., Agricultural Chemist, Travancore.
32. C. R. Harler, Chemist, Indian Tea Association, Tocklai.
33. N. V. Joshi, B.A., M.Sc., L.Ag., Offg. Assistant Agricultural Bacteriologist, Pusa.
34. J. N. Mukerji, B.A., B.Sc., First Assistant to the Imperial Agricultural Chemist.
35. A. V. Iyer, B.A., Assistant to the Imperial Agricultural Chemist.
36. B. M. Amin, B.A., First Assistant to the Indigo Research Chemist,

37. K. S. Viswanatham, B.A., Offg. First Assistant to the Imperial Agricultural Bacteriologist.
38. C. S. Rama Iyer, B.A., Offg. First Assistant to the Imperial Agricultural Bacteriologist.
39. P. B. Sanyal, M.Sc., Assistant to the Imperial Agricultural Chemist.
40. S. Das, M.Sc., Assistant to the Imperial Agricultural Chemist.
41. U. Sen Gupta, B.A., Assistant to the Imperial Agricultural Chemist.
42. N. N. Ghosh, Assistant to the Imperial Agricultural Chemist.
43. S. C. Biswas, B.A., Assistant to the Imperial Agricultural Bacteriologist.
44. N. Krishna Iyer, B.A., Assistant to the Imperial Agricultural Bacteriologist.
45. A. C. Ukil, M.Sc., Assistant to the Indigo Research Chemist.
46. N. C. Das Gupta, B.Sc., Assistant to the Indigo Research Chemist.
47. S. C. Dutt, B.Sc., Assistant to the Indigo Research Chemist.
48. A. K. Mitra, B.Sc., Assistant to the Indigo Research Chemist.

VISITOR.

In addition, Mr. S. Milligan, M.A., B.Sc., Agricultural Adviser to the Government of India, was present to open the proceedings of the meeting.

PROGRAMME.

SUBJECTS DISCUSSED.

The programme before the meeting consisted of the following subjects :—

- I.—Standardization of methods of analysis.
- II.—The present position of soil analysis and the direction in which progress is required.
- III.—The food values of Indian feeding stuffs and fodders.
- IV.—Bacteriological subjects—
 - (a) Availability of phosphate and the possibility of utilizing rock phosphate as manure.
 - (b) Fermentation problems.
- V.—Procedure to be adopted and subjects to be considered at future conferences.

PROCEEDINGS.

A combined meeting of Agricultural Chemists and Bacteriologists was held on Monday, the 7th February, 1921, when the proceedings were opened by **Mr. S. Milligan**, Agricultural Adviser to the Government of India, who **addressed the meeting as follows** :—

“ **MR. WARTH AND GENTLEMEN,**

“I have, in the first place, to welcome you all to Pusa and wish you all a successful gathering. This is the second Sectional Meeting of Chemists. You have come from all parts of India, and some of you are paying your first visit to this Institute, but I am sure that the results of the conference will justify the time and trouble of coming to Pusa. During the past few months, the chemical side of the Agricultural Service has been considerably strengthened. I am glad to see some of the latest recruits present here to-day and would extend to them a special welcome.

“It has been my melancholy duty to refer elsewhere to the lamented death of a promising member of the Indian Agricultural Service, and to the loss of the Agriculture Department of two of its most prominent members—**Mr. Mackenna** and **Dr. Butler**.

“I am specially glad to have this opportunity of addressing the chemists of the Agricultural Department. It seems to me that at last a definite change has been effected in the provincial departments which is likely to offer increased opportunities for research and investigation. This has come largely through the increased specialization in the provinces of two important branches—(1) agricultural engineering and (2) plant-breeding. The development of these two branches will react at once on the position of the agriculturist—I mean the agricultural experimentalist—who, up till now, has, in many cases and to a large extent, been engineer and plant selector too. To him we are indebted almost entirely for the development of farm machinery in India (which has resulted, in my opinion and in that of many others, in an immense improvement in the cropping on our agricultural stations), and to him also are due many of the new varieties of crops which are at present being grown in the districts. Relieved of this work, the agriculturist will now have time to devote his attention largely to matters affecting soil tillage and the growing of crops which after all constitute the main lines along which agricultural progress is to be expected. Now, it is obvious that increased assistance from the laboratory will be

required by the agriculturist and that a close collaboration between the two sections is necessary if any real progress is to be made. My own feeling is that collaboration on this subject will result in such strengthening of our knowledge of what goes on in the soil that we will be able to materially increase our out-turns and preserve fertility not by empirical methods but by methods founded on scientific knowledge. I am thus more than ever convinced of the necessity of strengthening the chemical (including the physical) side of our department.

"Now I am quite well aware that much research and much improvement in technique is required before many of the most important problems can be tackled. For this reason, technical conferences such as this are of the greatest importance. What I want to impress upon you all is that the agriculturist will more and more have to rely on the chemist not only for an interpretation of his everyday phenomena but for a knowledge of what is happening in the soil, a knowledge on which real progress in agriculture can alone be made."

Mr. F. J. Warth, Officiating Imperial Agricultural Chemist, then **addressed the meeting** in the following terms:—

"MR. MILLIGAN AND GENTLEMEN,

"Our programme, though it may not appear to be a particularly long one, will, we know, keep us very busy. Some important matters are to be dealt with, and we have an opportunity of doing very useful work.

"With regard to analytical processes to be employed in the analysis of manures, we would all like, in the first place, to express our thanks to those gentlemen who have carried out the long series of tests which we must shortly consider.

"Our first business will be to decide on the best means of utilizing the data submitted. We should then consider what further work of this nature is required, and finally you will agree we cannot leave this subject without discussing how the work is to be organized and placed on a permanent footing, and also how all test work that is not absolutely necessary is to be avoided.

"Mr. Somers Taylor has kindly consented to open the discussion on our second subject which refers to soil analysis.

"In this case we will be obliged to bear in mind that though there are very many aspects in which we are all deeply interested, we cannot expect to consider more than a few points fully on this occasion. These discussions will no doubt be of the greatest importance and interest to all of us.

"We must look further however.

"This soil work is the very essence of our activities, and it is most important to devise some scheme for the systematic survey of soil analysis problems. We can well afford to spend some time on this matter, if it enables us to agree on some tentative measure towards this end.

"Mr. Milligan has referred to co-operation between the chemists and the agriculturists.

"In connection with soil analysis and the determination of the absorption effects of soils, we require accurate and full field results to form a datum line for our laboratory results. Work of this kind would certainly increase the practical value of soil analysis. This question concerns us as a body, and we should decide how co-operation with the agriculturists will help us to deal with it. We have also much to learn from a study of the progressive changes in the crop and soil respectively which take place during the entire growing period. This work also demands close co-operation between the chemists and the agriculturists. This is, however, a local question which can only be taken up by each of us as individuals, and we will not attempt to discuss it at present.

"The discussion on animal nutrition is to be opened by me. At this initial stage only a few perfectly straightforward points will be raised.

"One day will be devoted to bacteriological questions. Mr. Walton will preside at this discussion, and I have, therefore, no remarks to make beyond stating that it is a very great help to hear the views of the bacteriologists of the department and to have their co-operation at our meeting.

"In conclusion, I would like to thank Mr. Milligan on behalf of this section for his presence here to open our meeting."

The meeting then proceeded to the discussion of the subjects contained in the programme, Mr. Warth in the chair.

SUBJECT I.—DISCUSSION ON PROCESSES TO BE EMPLOYED IN THE ANALYSIS OF MANURES.

The Determination of Phosphoric Acid. Mr. Somers Taylor, in introducing the subject of the determination of phosphoric acid in manures, pointed out that in the report drawn up by him he had not described the details of the methods used, as references were available in standard books and journals. The main work at Sabour and Pusa consisted of a large number of determinations of P_2O_5 carried out in duplicate by the volumetric Pemberton-Kilgore method and by the American official gravimetric methods.

It was found that the extreme variations from the mean of a number of determinations by the gravimetric method were somewhat lower than the variations obtained by the volumetric process.

It was found further that the means of the volumetric results were consistently slightly higher than the means of the gravimetric results. Some other methods were tested at Pusa and found suitable in particular cases.

On the whole, however, the volumetric method would appear to give reasonably accurate results.

From experiments on citrate-soluble P_2O_5 it was concluded that the very greatest care must be taken to adjust the temperature.

The point on which he would lay special stress was the very small quantities taken for the determination. For example, for the Pemberton-Kilgore method, only 80 mg. substance was taken, and for the magnesium pyrophosphate method only 160 mg. It was considered that the Pemberton-Kilgore method would no doubt give better results if larger amounts of substance were taken for estimation. Another point which he mentioned was the fact that during this work only one class of material was used, *viz.*, mineral phosphates, the experiments on bonemeal which were done at Pusa being only a few in number. It did not matter much that the analysis was carried out with solutions of mineral phosphates only and not with organic manures containing phosphoric acid, as before the analysis of these manures the phosphorus would have to be converted into the state of phosphoric acid.

The discussion then turned to various details in the report. The conference, however, decided to confine its attention in the first place to the method of estimation only.

Dr. Pendleton drew the attention of Mr. Somers Taylor to the very thorough study of the Pemberton-Kilgore method carried out by Hibbard and published in the "Journal of Industrial and Engineering Chemistry."

Dr. Sen pointed out that Hibbard's paper was a very valuable one but doubted whether it was necessary to go over the whole work again. It would be of more practical utility to adopt approved methods of procedure to local conditions.

Mr. Somers Taylor, Rao Saheb Ramaswami Sivan, Dr. Pendleton and Mr. Warth took part in a discussion on the amount of P_2O_5 which should be employed in the determination.

At Mr. Warth's request, Dr. Pendleton read out an extract from Hibbard's paper where considerable stress was laid on the fact that the amount of P_2O_5 taken should be within certain well-defined limits. "15 to 30 mg. of P_2O_5 is the most convenient amount. There is no advantage in more P_2O_5 as sensitiveness of the end point decreases in proportion as P_2O_5 increases, so that greater accuracy is not obtained by the use of larger amounts of P_2O_5 ."

The preparation of the molybdate solution was then considered and some references were made to the total volume of liquid to be employed during the process of precipitation.

Mr. Somers Taylor, reviewing the experimental data submitted to the conference, pointed out that, using the Pemberton-Kilgore method, the variations in the results obtained under slightly different conditions are not of higher magnitude than the limits of error of experiment when carried out by workers of average manipulative skill. Some work on the effect of silica had been done at Pusa.

Mr. S. Das drew attention to the fact that very good results had been consistently obtained for the last 15 years even with 5 to 15 mg. P_2O_5 by the modified method as followed at Pusa, where no ammonium nitrate is used.

Mr. Warth regretted that results by the Pusa method had not been submitted to the Referee. Under the circumstances it would be hardly fair to ask the meeting to accept the process. The method should be tested. In the meantime some reliable process should be recommended and adopted temporarily.

Mr. Davis agreed and suggested the advisability of now adopting a working method which would leave no choice to individuals and thus minimize chances of error.

The following resolution was, therefore, moved by Mr. Davis, seconded by Mr. Somers Taylor and carried unanimously.

"That for the determination of phosphoric acid in fertilizers, the Pemberton-Kilgore method as specified in the official and tentative methods of analysis (1919) of the Association of Official Agricultural Chemists be adopted as a provisional method, subject to the proviso that it be used for quantities within the limits 15 to 30 mg. phosphoric acid in the precipitate. That the official gravimetric American method be adopted as official with the proviso that the quantity of phosphoric acid in the precipitate should not be less than 0.1. grm."

Resolution I.

The question of the method of solution was raised by Messrs. Wilsdon and Padmanabha Iyer. The various official American methods were referred to by Dr. Pendleton who pointed out that each particular method was intended for a definite class of material. In this connection Mr. Somers Taylor emphasized the fact that there was one method which was practically applicable in all cases and that this was the one used in his experiments.

Dr. Iyengar then proposed the **following resolution** which was seconded by Dr. Sen and **carried unanimously**.

Resolution II.

“That in the estimation of phosphoric acid, the official American method be adopted temporarily for the preparation of the sample and for effecting solution.”

A discussion on the citrate-soluble P_2O_5 was then started by Mr. Warth. In this connection Mr. A. V. Iyer brought forward the fact that very wide variations are observed according as citric acid or ammonium citrate is used for the extraction, and that it is very difficult to decide which of them is to be used.

Mr. Somers Taylor doubted whether a knowledge of citrate-soluble P_2O_5 was of much practical use in the case of any material except superphosphate. He considered it to be more important to determine the total or the water-soluble P_2O_5 .

Mr. Warth drew attention to the work which has been carried out in America on this subject. The conclusion arrived at there was that ammonium citrate was preferable to either citric acid or sodium citrate, for the purpose.

Rao Saheb Ramaswami Sivan said that the difficulty was that whereas ammonium citrate was very often used in the laboratory for extraction the manufacturers had recourse to citric acid. On the whole he preferred a neutral solution of ammonium citrate of S. G. 1.09 to be used at $65^\circ C$. A difficulty in all such methods of extraction was the presence of lime. He asked for information as to the results obtained in Pusa in this connection.

Mr. Das said that the ammonium citrate method as generally carried out was useless because it did not differentiate between di- and tri-calcic phosphates. In the presence of calcium carbonate widely varying results were obtained at 65° but at ordinary laboratory temperatures, *viz.*, 20° – $30^\circ C$., the results were concordant.

Mr. Viswanath enquired why preference should not be given to the use of 1 per cent. citric acid solution as this reagent was used in the case of soils.

Mr. Das said that in this case the presence of any basic substances like calcium carbonate would interfere with the reaction.

Mr. Warth expressed the opinion that until more is known of the actual effect of the various phosphates in increasing the out-turns of field crops, the value of ammonium citrate and citric acid for extraction could not be properly appraised.

Mr. Walton then moved the **following resolution** which was seconded by Rao Sahib Ramaswami Sivan and **carried unanimously**.

“ That in the absence of certainty as to the most reliable method for the determination of citrate-soluble phosphoric acid in fertilizers in this country, the American standard method be temporarily adopted.” Resolution III.

The Determination of Nitrogen. Mr. Wilsdon opened the discussion on the determination of nitrogen in manures. In his report he showed that the work naturally divides itself into four sections as follows:—

- (a) *Determination of Organic Nitrogen.* The results showed that the Pusa method was simple and effective in most cases. For very refractory substances the Dyer and Arnold methods were shown to be satisfactory.
- (b) *Nitric Nitrogen.* The phenol-sulphonic method was not recommended. The zinc iron reduction method was found to be accurate and easy to work.
- (c) *Total Nitrogen including Nitrates.* The use of sulphosalicylic with zinc or with thio-sulphate for the reduction was tested. Both reducing materials gave accurate figures.
- (d) *Ammonia in Am. Salts.* These were not carried out.

In connection with the report on the work done, he pointed out that the object was to fix on methods which while giving reliable results would not take up too much time. To facilitate discussion he suggested considering each of the above sections in turn, commencing with organic nitrogen.

Mr. Mukerji described the results of experience with the several processes of determination tried at Pusa. The Gunning method using potassium sulphate alone is not satisfactory as it takes a long time and the results are low. The addition of copper sulphate effected a marked improvement. The Pusa method had

also been found to be very satisfactory. For refractory substances, the Kjeldahl-Gunning-Arnold method where copper sulphate, mercuric oxide and potassium sulphate are used, and Dyer's modification of the process, in which only mercuric oxide and potassium sulphate are used, are to be preferred.

Mr. H. D. Sen confirmed the statement of Mr. Mukerji and said that with the opium alkaloids Dyer's method had proved quite satisfactory and was to be preferred to the Gunning process.

Then followed a general discussion regarding details of manipulation in which many members took part.

In connection with the contention of Mr. Pal that a larger number of duplicate determinations in individual samples should have been made, Mr. Wilsdon pointed out that, as the tests were carried out at Pusa on a considerable variety of substances and gave uniformly satisfactory results, the method had been proved to be of general applicability.

Dr. Norris then moved the **following resolution** which was seconded by Mr. Padmanabha Iyer and **carried unanimously**.

Resolution IV.

"That for the determination of organic nitrogen in fertilizers the Pusa method be employed for general laboratory practice, but in the case of particularly refractory substances Dyer's method is recommended for use."

Mr. Wilsdon then passed on to the problem of determination of nitrates, and reviewed the comparative merits of various methods. The colorimetric method was found at Lyallpur to be unreliable for soils. The gasometric method is good for fertilizers but takes a long time and is not very convenient for ordinary routine work. The alkaline reduction method, with the help of iron and zinc, has given good results at the Lyallpur laboratory, and the acid reduction method with iron has been found satisfactory at Pusa. The nitron method is not suitable in the case of fertilizers which generally contain a high percentage of nitric nitrogen.

Mr. Mukerji stated that while the colorimetric method is not suitable for use in the presence of large amounts of chlorides, it can be advantageously utilized for the quick determination of nitrates in commercial samples of refined saltpetre. Ulsch's method as modified by Street gave very good results in his experience.

Mr. Padmanabha Iyer, in confirming Mr. Mukerji's remark regarding Ulsch's method, pointed out that it had been recommended for the purposes of analysis under the Fertilizers and Feeding Stuffs Act in Great Britain.

As regards Warrington's method, the general opinion of the conference was that the process was not suitable for routine work.

Mr. Davis then proposed the **following resolution** which was seconded by Dr. Norris and **carried unanimously**.

"In view of the satisfactory results with Ulsch's method Resolution V.
reported both in presence and absence of organic matter and in view of the fact that it has been adopted by the English Fertilizers Act, that method be employed for determinations of nitric nitrogen in fertilizers during the next two years."

Mr. Wilsdon then passed on to the determination of total nitrogen in presence of nitrates. Both at Pusa and at Lyallpur reduction with sulpho-salicylic acid in presence of sodium thio-sulphate or zinc dust yielded good results. Many members expressed the opinion that in their experience reduction with the help of thio-sulphate is preferable to reduction with zinc dust.

Mr. Wilsdon then proposed the **following resolution** which was seconded by Dr. T. M. Singh and **carried unanimously**.

"That in the determination of total nitrogen in organic fertilizers, to include nitrates, reduction with salicylic sulphuric acid and thio-sulphate should be adopted as official." Resolution VI.

The Determination of Potash. Mr. Davis' report gives complete details for the preparation of the solutions and for carrying out the determination by the Lindo-Gladding and perchlorate methods.

The strength of alcohol required for washing the potassium platinum chloride is discussed, and the use of 80 per cent. alcohol saturated with the double salt considered.

In the perchlorate method attention is called to the necessity for testing the purity of the perchloric acid, the advantage of baryta over barium chloride for removing sulphates, and details of manipulation.

Tests of the perchlorate method as carried out by the author are shown to give results which approached very closely to the mean calculated from the results of 8 analysts.

In opening the discussion Mr. Davis laid stress on the fact that, owing to the greater liability of the dissolution of potassium platinum chloride in the wash alcohol at the relatively high temperatures prevailing in Indian laboratories, the platinum method is less suitable than the perchloric method. If the washing is not thoroughly done there is a chance of impurities like sodium chloride being included in the precipitate. On the other hand, over-washing would dissolve some of the double chloride of potassium and platinum. In this connection mention was made of the work done by Morris (*Analyst*, October 1920) who recommended certain modifications of the process.

Mr. Pal, at the request of Mr. Davis, gave an account of his work on the determination of potash.

A study was made of (a) the Lindo-Gladding method, (b) the same modified by using 80 per cent. alcohol saturated with potassium platinum chloride as the final wash liquid, and (c) the perchloric method. In the case of fertilizers and soils, Mr. Pal stated that the modified platinum method gave higher results and that the perchlorate method yielded the highest figures, which are apparently due to the deposition of potassium perchlorate.

Mr. Padmanabha Iyer was of opinion that the platinic method was to be preferred to the perchloric process.

Mr. A. V. Iyer pointed out that the difficulty referred to by Mr. Davis regarding the determination of the point at which the washing of the double chloride of potassium and platinum with alcohol was complete, could be overcome by stopping the washing when the filtrate is free from chloride.

Referring to the increase of weight in the resultant precipitate of potassium perchlorate, Mr. Somers Taylor dwelt on the possibility of the reduction of perchloric acid by alcohol to hydrochloric acid and the subsequent formation of sodium chloride for example in the presence of sodium salts.

Mr. Wilsdon pointed out that there was also a possibility of the precipitation of potassium perchlorate when the wash alcohol saturated with potassium perchlorate comes in contact with any perchloric acid adhering to the precipitate or to the Gooch crucible.

Mr. A. V. Iyer said that washing with 5 c.c. of 98 per cent. alcohol would minimize the risk of contamination of the precipitate. The removal of the perchloric acid would thus be effected before washing with alcohol saturated potassium perchlorate begins, and this would give better results.

Mr. Pal then moved the **following resolution** which was seconded by Mr. Davis and **carried unanimously**.

“That for the determination of potash in fertilizers, the Lindo-Gladding method and the perchloric acid method modified by using 5 c.c. of 98 per cent. alcohol before using alcohol saturated with $[KCO_3]$ be adopted for the present, and that further study be made of the perchloric method.” Resolution VII.

Mr. Warth was of opinion that the investigation on the analysis of manures should be continued by a committee which would consider all promising processes and recommend suitable ones for adoption.

Mr. Mutkekar thought that there should be a representative of each of the provinces on the committee. It was pointed out by Mr. Davis that such a procedure would make the committee very unwieldy. He added that results obtained by every worker in the provinces would be most welcome.

Dr. Norris said that, as a committee will presumably be appointed for the analysis of soil constituents, it would be perhaps more profitable to defer the consideration of the appointment of the committee on manures till the question of soil analysis was considered.

SUBJECT II.—THE PRESENT POSITION OF SOIL ANALYSIS AND THE DIRECTIONS IN WHICH PROGRESS IS REQUIRED.

In opening the discussion on this subject, Mr. Somers Taylor read a paper the full text of which is given as Appendix.

He showed how the theories of the greatest workers in the past had in turn been upset, and concluded that the great difficulties which obscured the correct interpretation of soil phenomena were due to the diversity of problems to be solved.

Turning to more recent developments, Whitney's views regarding the soil solution and the importance to be attached to mechanical analysis were dealt with.

It was shown that so long as Whitney's theories were employed for the comparison of soils with a view to the introduction of new crops success was attained.

It was the extension of these doctrines to find an explanation for fertilizer action that met with direct opposition from the English school.

The work of Hall, Brenchley and Underwood in support of the direct nutrient effect of fertilizers was referred to, and the

main conclusion arrived at by these workers very concisely stated.

Emphasis was laid on the fact that soil phenomena are complex. They may be studied from the biological, physical and chemical points of view. In each case the object is the same, namely, to diagnose the needs of the soil.

It was shown that all progress had been attained by the study of special subjects, reference being made to the work of Whitney and Harrison.

A review of soil problems shows that progress is required in all directions. In India perhaps the most profitable line of work should be the determination of the fertilizer requirements of soils. Ball and his co-workers have produced evidence enough to give us confidence in this line of work.

Our path is, however, beset with many difficulties.

Mr. Warth expressed the thanks of the conference to Mr. Somers Taylor for his admirable note on the present position of soil analysis. He further said that it was very desirable to gauge the fertilizer requirements of soils by chemical means.

Mr. Wilsdon dwelt on the limits of reliability of field trials, and emphasized the necessity of supplementing them by studies of the fundamental constitutional properties of the soil rather than the accidental properties. Methods must be devised for the study of the soil solution *in situ*.

Dr. Pendleton drew attention to the fact that probable error of sampling the soil of a field is often comparatively large.

Mr. Das referred to the results obtained at Pusa in connection with the phenomenon of absorption of P_2O_5 by calcareous and non-calcareous soils.

Mr. Warth said it is very necessary to have recourse to field trials and to correlate this with the chemical and physical properties of the soils under investigation.

Messrs. Plymen and Davis pointed out that it is practically impossible to have a field which is quite uniform, and gave instances to show that a field which was apparently of the same nature throughout the whole plot often showed great variation in crop growth. In an interesting case of a field which gave uniform crops of wheat and oats, the growth of indigo was very uneven. This was ultimately traced to variation in the nature of the subsoil.

Dr. T. M. Singh dwelling on the lack of uniformity as regards the chemical composition of soils in the field emphasized the necessity of field experiments.

Mr. Davis pointed out that the chemical analysis of soil is not the only factor to be studied although it is no doubt a very important one. The various other factors should also be considered.

Mr. Warth said that the crop-yields form the datum line with the help of which one can form a judgment of the significance of the chemical properties of a soil. The aim should be to find out the relation of the average composition of a soil to the growth of crops on it.

Mr. Wilsdon proposed the **following resolution** which was seconded by Dr. T. M. Singh and **carried unanimously**.

“That it is recognized that the ultimate decision on the effect of fertilizers on soils must be by cropping experiments. It is therefore recommended that agricultural chemists should as far as possible place on record, as they become available, figures for the chemical and mechanical analyses of soils which have an agricultural history.”

Resolution VIII

In this connection Dr. Pendleton pointed out that it was very necessary to include also a description of the soil and its physical properties. This was agreed to by the meeting.

Mr. Plymen suggested that there should be a museum at Pusa where specimens of different types of Indian soils should be kept along with records of details about their analytical and other records of known composition and crop-yielding capacity.

Mr. Warth then passed on to the question of choosing methods for the analysis of soil.

This opened a general discussion on the importance of fixing standard methods of analysis, the consensus of opinion being that even empirical processes if systematically carried out must yield results which could be correlated with actual crop growth.

Dr. Norris laid stress on the great want of reliable data on this subject and insisted that it was of the utmost importance that systematic efforts should be made to have more thorough information on the subject.

In this connection Dr. Pendleton said that, in cases where it is not possible to agree as to any conventional methods, it is of the utmost necessity to describe in detail the actual processes of analysis.

Mr. Davis proposed the **following resolution** which was seconded by Rao Saheb Siyan and **carried**.

Resolution IX.

“ A committee be formed for the following objects :—

- “(1) Preparing and circulating details of the standard method to be adopted for analysis of fertilizers.**
- “(2) Circulating proposals for the determination of the ordinary soil constituents. The methods proposed to be worked as provisional methods during the next two years, tested, reported on, and the report discussed at the next conference before final acceptance.”**

In connection with the above resolution Mr. Plymen proposed that the following gentlemen be appointed as members of the Committee :—

Mr. F. J. Warth.

Dr. J. Sen.

Mr. J. H. Walton.

Mr. W. A. Davis.

Mr. C. S. Taylor.

Mr. B. H. Wilsdon.

Dr. R. V. Norris.

Mr. V. A. Tamhane.

This was seconded by Rao Saheb Sivan and was carried unanimously.

Mr. Warth referred to the importance of closer co-operation with the agriculturists in order to gain a more thorough knowledge of the productiveness of soils.

Dr. Sen stated that it was very desirable that the chemists should not give the whole of their attention to the laboratory study of agricultural problems as the conditions here are quite different from those prevailing in the fields. The agriculturist closely follows the growth of crops in the fields, and many important problems connected with plant growth come to his notice. It is here that the scientists can render him help by carrying out systematic studies of the different factors concerned.

Mr. Plymen emphasized the importance of co-ordinating work under the joint direction of agriculturists and scientists, and suggested the formation of committees to lay down schemes of agricultural work.

Messrs. Sahasrabudhe and Kanitkar described the existing arrangements in Bombay where a committee of scientists and agriculturists carefully examine all problems of study and lay

down schemes for work. In special cases where particular problems have to be dealt with special committees take these up.

Mr. Warth dwelt on the importance of collaboration of chemists with agriculturists in the study of manurial and soil fertility experiments as this would supply a datum line for soil analysis.

Dr. Pendleton maintained that committee organization entailing an association of all branches of work leads to great benefit as is being now recognized throughout America.

Dr. Norris then moved the **following resolution** which was seconded by Mr. Wilsdon and **carried unanimously**.

“That permanent field experiments, such as manurial experiments or any experiments carried out in relation to soil fertility, should before initiation be submitted for consideration by a committee consisting of the deputy director, the agricultural chemist, and the bacteriologist. When once initiated, such experiments should not be altered or discontinued without the sanction of such a committee.”

Resolution X.

With regard to the printing of the reports on analysis, the conference agreed to the Chairman's view that it should be left to the committee of analytical processes to decide on the best means of dealing with the information which had been collected. The Chairman also pointed out that any analytical experiments which could be utilized by the committee of analytical processes would no doubt be welcomed and would be duly acknowledged.

SUBJECT III.—THE FOOD VALUES OF INDIAN FEEDING STUFFS AND FODDERS.

Mr. Warth, in opening the subject, spoke as follows :—

“This subject was proposed by me for the chemists' conference because, in the first place, we are frequently called upon to analyse and report on fodders and are on that account interested in the accumulation of data on nutrition ; and, secondly, because animal nutrition is intimately connected with both agriculture and chemistry, and therefore the agricultural chemists are in a position to give sound advice regarding this proposed new undertaking of the Agricultural Department.

“I do not propose to lay before you a programme of work. Instead it is perhaps better at this stage to call attention to some of the questions which should take precedence in animal nutrition work in India,

“ Amongst these the following should be included :—

“(1) A systematic examination of the food values and digestion co-efficients of the chief feeding stuffs and fodders of the country. Special stress would have to be laid on those products which are most widely used and those which are peculiar to India and have not been investigated elsewhere. Normal variations in composition and corresponding variations in digestibility should also be considered.

“ This is a large field of work and might be claimed to form the spade work on Indian animal nutrition.

“(2) Data for maintenance and working rations for bullocks are of considerable importance. Under this head the effect of the different seasons of the year appear to be fully worth consideration.

“(3) Regarding accessory food factors there have been some recent developments which seem to be of first class importance in this country. The two following points deserve special attention.

“(a) It has recently been established by several workers that vitamin A in milk varies with the food given to the cows.

“ This must have a very great influence on the development of young stock. The point deserves study here.

“(b) Recent investigations on the content of vitamin A in vegetable oils are highly suggestive and promising.

“ To put the matter in a few words, it has been found that whilst fresh seeds generally give negative results, the expressed oils in some cases give definitely positive results.

“ The work on this subject is in its initial stages; the experiments show nevertheless that there is a prospect of obtaining from vegetable oils and cakes (if they are treated in a suitable way) the growth-promoting factor. For an oil-seed producing country like India this subject is worth independent study here.

“ The observations also indicate that some real significance may be found for such indigenous practices as the long soaking of oil-cake before feeding it to cattle.

“(4) The effect of soil and manure on the food value of crops.

“ The splendid work at Cockle Park has shown that the nutritive effect of hay from equal areas varies—not with the yield—but with factors which are at present termed quality.

“ The effect of manure on feeding efficiency of fodder grown on exhausted soils is a matter which deserves attention in India.

"The question of manuring economics is evidently deeply involved in this subject.

"(5) Toxicity of agricultural products. This is a smaller question but work on it must be anticipated from time to time.

"(6) Work in connection with the Pusa cattle. The dairy and breeding herds here offer a unique opportunity for the study of nutrition in relation to milk production and in relation to the rearing of young stock.

"This would form one of the main lines of work in any case.

"It is perhaps less important to discuss in detail each of the above questions than to consider what the scope of nutrition work should be.

"Chemical work on nutrition is to be started. A special staff and laboratory are to be provided. Should these resources be devoted mainly to the dairy question? Or is it advisable to utilize this nucleus, enlarging the staff as the work expands, for the study at the same time of some of the more general problems of nutrition outlined above?"

Mr. Sahasrabudhe expressed the opinion that attention should not be restricted to a study of the dairy question but should be extended to general problems relating to feeding stuffs. In this connection he mentioned a very interesting instance of a sample of forest grass from Baroda which caused night blindness and pain in the joints of horses consuming the fodder. The sample when subjected to a very careful chemical and mycological examination failed to reveal the presence of any injurious substances. In his opinion the injurious effect was probably to be attributed to lack of vitamins.

Dr. Norris was of opinion that it was more important to go into the general question connected with the feeding of work-cattle than into that of dairy cattle. It is at present impossible to judge the value of any of the feeding stuffs in India, and the basis of the comparison is always derived from results obtained in other countries in the absence of any reliable Indian data. In view of the idiosyncracies of individual animals it is very important to experiment with a large number of animals. It is necessary to have a very big and comprehensive scheme.

Mr. Davis pointed out that Pusa is from one point of view an ideal place for the study of the animal nutrition problem. It was originally an important horse-breeding station for about 50 to 60 years but ultimately this industry had to be abandoned owing to the deterioration in quality of the horses as nervous diseases and weakness of bones were developed. It would be

desirable to find out whether this is due to any deterioration in the quality of the feeding stuffs and the consequent liability of the appearance of deficiency diseases.

Rao Saheb Sivan maintained that from his experience at Coimbatore and Saidapet it can be stated that the standards fixed in foreign countries do not hold good with reference to the maintenance diet. The digestion co-efficient of Indian feeding stuffs should be very carefully determined.

Mr. Plymen gave out the opinion that Indian fodders are lamentably poor in proteids as compared with ordinary fodder grown in temperate climates. The quality of the fodder supplied is of great importance in the maintenance of breeding herds. He agreed with Dr. Norris as to the importance of the subject of general nutrition of work cattle, as attention is usually paid to the feeding of dairy cattle. It is notorious that Indian cattle are weak in bone, and this is most probably associated with the poor quality of their food. He referred to the possibility of improving the quality of the fodder by judicious selection and efficient systems of manuring.

Mr. Davis then proposed the following resolution which was seconded by Dr. Norris and carried unanimously.

Resolution XI.

“That it is undesirable to limit the scope of the work on animal nutrition to a too narrow field, but that work should be pursued on more general lines, including particularly the relationship between quality of crops and fodder, and conditions generally which determine good nutrition. Such general studies are necessary preliminaries to work in all branches in animal nutrition.”

SUBJECT IV.—BACTERIOLOGICAL SUBJECTS.

(a) AVAILABILITY OF PHOSPHATE AND THE POSSIBILITY OF UTILISING ROCK PHOSPHATE AS MANURE.

(b) FERMENTATION PROBLEMS.

Mr. J. H. Walton, Offg. Imperial Agricultural Bacteriologist, who now occupied the chair, addressed the meeting in the following terms:—

“MRS. NORRIS AND GENTLEMEN,

“In a meeting such as this it would be out of place to indulge in a discussion upon technical bacteriological methods.

“The soil bacteriologist has to be acquainted with the details of and has to carry out nitrogen, phosphoric acid and potash

determinations, and I welcome the decisions of this conference in recommending the adoption of standard methods for the determination of these soil constituents.

"These should greatly assist the bacteriologist by taking from his shoulders the burden of selecting satisfactory analytical methods.

"We bacteriologists have listened with interest to the discussions which have decided these chemical questions, but we cannot expect the chemists to be equally interested in discussions relating to the composition of media or to methods suitable for sterilization of glassware.

"I would like to suggest that at the next conference some arrangements may be arrived at by which the bacteriologists may withdraw while purely chemical work is being discussed, and try to put their own house in order.

"During the discussion of bacteriological subjects at the last conference two resolutions were carried unanimously. I would like to remind you of these. One of these was :—

A full discussion of provincial conditions indicates that there is an urgent demand for the investigation of bacteriological problems whether connected with the soil or with agricultural industries.

In the past agricultural chemists have been able to deal with some of these problems, which are purely chemical in character, but it is difficult, and in many cases impossible, for such officers to find time for such investigations.

This meeting, therefore, recommends that Local Governments should seriously consider the desirability of adding an agricultural bacteriologist to their respective scientific staffs.

"With reference to this resolution I am glad to say that the Government of Madras now has a bacteriologist in Mrs. Norris, whom we are very pleased to see with us this morning. Other provinces have assistants for bacteriological work, and I trust that the day will soon come when all will have at least one bacteriologist in the Imperial Agricultural Service. For you will all, no doubt, agree that there is still an urgent necessity for investigations in the field of agricultural bacteriology.

"The other resolution was this :—

That this meeting is of the opinion that it will be an advantage in the biological analysis of soils to adopt as far as practicable standard conditions of work, and suggest that the tentative scheme now put forward be submitted to the agricultural chemists interested in such work who may be asked to report the results of their investigations to the Imperial Agricultural Bacteriologist with a view to the formulation at a later date of complete scheme generally suitable to Indian conditions.

"I regret to say that to my knowledge no results have been forwarded by the chemists. Indeed it has been said that the proposed scheme was too complicated and demanded more analytical work than the chemists had time to undertake.

"However, even though the scheme might not be worked on in full, much suggestive information may be obtained from portions of it, and results derived from, say, ammonia formation and nitrate formation, would be most valuable.

"There has been a complaint of lack of data for the chemist to work on. The bacteriologist is in a far more unenviable position, and in this connection results obtained by chemists on the lines above laid down would be of great use to the bacteriologist—more specially in connection with the possible modification of the scheme.

"To come to the subjects mentioned in the programme—

"*Phosphate.* On this subject much has been published in America but I am afraid that the results obtained cannot be accepted as applicable to India. The conditions are different and the materials too are different.

"A number of chemists of this department are doing a large amount of work on natural phosphates and their use in agriculture, and I should be very glad to have the benefit of their experience.

"*Fermentation problems.* This is one of the widest fields of all, and I should like to know what is being done with a view to instituting a frequent interchange of information between those who are working on any particular problem, but under very varying local conditions."

Mr. Warth described his green-manuring tests with and without phosphoric acid. The soil was deficient in phosphoric acid so far as the requirements of the paddy crop were concerned but contained a sufficient amount of phosphoric acid for the needs of the bacteria decomposing the green manure. Therefore the phosphoric acid datum line for growing paddy may be different from that for the growth of bacteria attacking green manure. He also mentioned the enormous difference in the rates of decomposition of different green manures, *e.g.*, grass and legumes, which he noticed in his cultural tests. The amount of growth of paddy agreed with the ammonification of different manures.

Mr. Somers Taylor referred to his experiments with rock phosphates in field trials. Phosphates by themselves rather somewhat depressed the yield and green manure alone did not largely increase the yield, but green manure used in conjunction with superphosphate produced an enormous increase amounting at times to 100 per cent. The rock phosphate used in this

experiment was flour apatite from the south-east of Bihar and Orissa.

Dr. Norris then gave an account of his experiments which were more promising. At the Mangalore farm good results were obtained when paddy was manured with Trichinopoly phosphate and green manure. Some experiments were also done on composting raw phosphates with green manures. The results, although uneven and indefinite, were promising. The investigation was also continued in the laboratory, the results of which were somewhat confusing. This might have been due to the method of estimating available phosphoric acid being at fault or to an inversion of phosphoric acid taking place.

Rao Sahab Ramaswami Sivan gave a detailed account of his experiments with Trichinopoly phosphates which occur in very large amounts within a comparatively small area. These phosphates, however, contained relatively large amounts of iron and aluminium oxides as also considerable quantities of calcium carbonate. Then conversion into superphosphate was found impracticable owing to the necessity of using excessive quantities of sulphuric acid. The application of these phosphates in the form of fine powder was also found not to have any marked effect on the yield of crops. An attempt was therefore made to utilize them in some other way, specially as the results of soil surveys in Tanjore District revealed the poverty of these soils in phosphoric acid. A series of pot tests were carried out with paddy crop, the soil treatments being no manure, phosphates, green manure, and green manure *plus* phosphate. The phosphate alone did not produce any increase, and the plants were yellow and transpiration small. Green manure, however, produced healthy plants and gave better outturn which was improved by addition of phosphate. Promising results have also been obtained on a field scale at Salem. The necessity of correlating the determination of available phosphates with the growth of the crop in the field was also emphasized.

Mr. Mutkekar narrated some of the experiments he conducted with rock phosphates in America for the purpose of determining the rate of their availability under different systems of green-manuring. The green manures used were rape, beets and barley, the crop grown being oats. Monthly determinations of available phosphoric acid in the soils were carried out, and it was found that there was no appreciable variation in the amounts present in the soils in different pots during the first year. In the second and third years, however, there was noticed an appreciable increase in the soils of the pots to which rape plants were added.

The oats grown in these pots matured and seeded early. It is thus apparent that the character and rate of decomposition of green manure influences the rate of crop growth.

Mr. Somers Taylor drew attention to the fact that the nature of rock phosphate used was of importance. The rock phosphates used in Madras were more soluble than the apatite he used. In his experiments he found that while ordinary phosphates produced good results, apatite produced none.

Mr. Davis said that it is very difficult to grow legume in Bihar soils without a preliminary treatment with soluble phosphates. The main function of the phosphate seems not so much in directly increasing the plant nutrients as in rendering the soil conditions more favourable for bacterial growth. Stimulation of bacterial activity leads ultimately to an increase of green manure crop. The indigo soils of Bihar, which are all very deficient in total and available phosphoric acid, may be divided into two classes. In Champaran the soil is rich in humus and responds to the application of superphosphate. On the other hand, in the eastern districts of Tirhoot the soil is deficient in available organic matter. Here no proper bacterial growth is possible without the application of organic matter even when enough phosphoric acid is added. The soils require the combined application of green manure and phosphates. The nitrogen of green manure is superior to nitrogen in other forms. Indigo bacteria do not develop properly in ordinary nitrogenous media, although the growth is very good in indigo extract. It thus seems that a specific substance, *e.g.*, a particular amino acid or vitamine is essential for the development of these bacteria.

Mrs. Norris said that in her experience also it was noticed that for bacterial growth small quantities of specific compounds appeared to be necessary.

Mr. Wilsdon found that the concentration of nutrients exerts a great influence on the process of nitrification. In the green-manuring experiments conducted at Lyallpur and Gurdaspur, it was found that the beneficial effects of green-manuring were largely due to the improvements in the physical condition of the soil.

Dr. Singh quoted the results of some American experiments with raw rock phosphate, with and without the addition of sulphur, which effected an improvement in ammonification and nitrification in acid soils. Calcareous soils did not respond to this treatment.

Dr. Norris found in his experiments that the presence of calcium carbonate was not injurious but on the other hand seemed to favour the decomposition of rock phosphates in compost heaps.

Mr. Joshi said that in his work on the effect of soluble phosphates on bacterial activities in soil it was found that soluble phosphates depressed nitrification but had a stimulating effect on ammonification. He suggested, therefore, that some of the contradictory results might be explained by this influence of the phosphates on nitrogen changes in the soil, as some crops are benefited by ammoniacal nitrogen and others by nitrogen in the form of nitrates. Indigo and rape were found to have derived much benefit by the application of phosphate in field experiments, while the growth of oats and wheat was not affected to any great extent.

Mr. Davis laid emphasis on the beneficial effects brought about by the application of green manure and phosphates on a leguminous crop like indigo. This was in his opinion due to the favourable development of the nodule bacteria which brought about an increase in the indican content of the leaf.

In Mr. Plymen's experience the application of superphosphate before sowing the green manure crop produces better results than the application of superphosphate at the time of ploughing in the green manure. He further said that the degree of fineness of rock phosphate was of great importance.

With reference to the influence of phosphates on the nitrogen changes in the soil to which attention had been drawn by Mr. Joshi, Rao Saheb Ramaswami Sivan said that the problem would be studied in his new experiments.

At this stage Mr. Walton vacated the chair, and the discussion on chemical subjects was resumed with Mr. Warth in the chair.

Dr. Norris brought forward the subject of mechanical analysis of soil. It was essential to decide what preliminary treatment should be given to the sample of soil. A uniform method of analysis should also be fixed upon.

A general discussion then followed in which many members took part.

The **following resolution** which was proposed by Dr. Sen and seconded by Mr. Tamhane **was carried unanimously.**

"As the subject of mechanical analysis of soils is of importance, a small committee be appointed to critically examine and recommend a suitable method." Resolution XII.

Dr. Sen then proposed that Messrs. Plymen, Tamhane and Wilsdon be appointed members of this committee on mechanical analysis of soil. This committee was thereupon duly appointed.

On Mr. Padmanabha Iyer's enquiry as to the action taken on the resolutions passed at the last conference it was pointed out by Mr. Wilsdon that the subject of soil survey has already been taken up in the Punjab, and Dr. Norris drew attention to the fact that in Madras the staff was being duplicated for teaching and research work, as recommended in one of the resolutions passed at the last conference.

Mr. Wilsdon asked for an expression of opinion of the conference on the question of leave reserve.

Rao Saheb Ramaswami Sivan drew attention to the fact that the Royal Commission on Public Services had negated the idea of maintaining a leave reserve as it was only when the Experts go on leave that the Indian assistants get a chance of officiating in these posts and of proving their fitness or otherwise.

Mr. Warth thanked the members of the conference for their hearty co-operation during the discussions.

Mr. Plymen, on behalf of the visitors, expressed thanks to the authorities at Pusa for their hospitality.

The meeting then terminated.

List of Resolutions Passed at the Second Meeting of Agricultural Chemists and Agricultural Bacteriologists held at Pusa on the 7th February, 1921, and following days.

1. That for the determination of phosphoric acid in **Subject I.** fertilizers, the Pemberton-Kilgore method as specified in the official and tentative methods of analysis (1919) of the Association of Official Agricultural Chemists be adopted as a provisional method, subject to the proviso that it be used for quantities within the limits 15 to 30 mg. phosphoric acid in the precipitate. That the official gravimetric American method be adopted as official with the proviso that the quantity of phosphoric acid in the precipitate should not be less than 0.1 gm.
2. That in the estimation of phosphoric acid, the official American method be adopted temporarily for the preparation of the sample and for effecting solution.
3. That in the absence of certainty as to the most reliable method for the determination of citrate-soluble phosphoric acid in fertilizers in this country, the American standard method be temporarily adopted.
4. That for the determination of organic nitrogen in fertilizers the Pusa method be employed for general laboratory practice, but in the case of particularly refractory substances Dyer's method is recommended for use.
5. In view of the satisfactory results with Ulsch's method reported both in presence and absence of organic matter and in view of the fact that it has been adopted by the English Fertilizers Act, that method be employed for determination of nitric nitrogen in fertilizers during the next two years.
6. That in the determination of total nitrogen in organic fertilisers, to include nitrates, reduction with salicylic sulphuric acid and thio-sulphate should be adopted as official.
7. That for the determination of potash in fertilizers, the Lindo-Gladding method and the perchloric acid method modified by using 5 c.c. of 98 per cent. alcohol before using alcohol saturated with KClO_4 be adopted for the present, and that further study be made of the perchloric method.
8. That it is recognized that the ultimate decision on the **Subject II.** effect of fertilizers on soils must be by cropping experiments. It is therefore recommended that Agricultural Chemists should as far as possible place on record, as they become available, figures for the chemical and mechanical analyses of soils which have an agricultural history.

9. A committee be formed for the following subjects :—

(1) Preparing and circulating details of the standard method to be adopted for analysis of fertilizers.

(2) Circulating proposals for the of determination of the ordinary soil constituents. The methods proposed to be worked as provisional methods during the next two years, tested, reported on, and the report discussed at the next conference before final acceptance.

10. That permanent field experiments, such as manurial experiments or any experiments carried out in relation to soil fertility, should before initiation be submitted for consideration by a committee consisting of the deputy director, the agricultural chemist and the bacteriologist. When once initiated such experiments should not be altered or discontinued without the sanction of such a committee.

Subject III.

11. That it is undesirable to limit the scope of the work on animal nutrition to a too narrow field, but that work should be pursued on more general lines, including particularly the relationship between quality of crops and fodder, and conditions generally which determine good nutrition. Such general studies are necessary preliminaries to work in all branches in animal nutrition.

12. As the subject of mechanical analysis of soils is of importance, a small committee be appointed to critically examine and recommend a suitable method.

APPENDIX

Note on Subject II.—Soil Analysis.

(MR. C. SOMERS TAYLOR, AGRICULTURAL CHEMIST TO THE GOVERNMENT OF BIHAR AND ORISSA.)

I am rather afraid of opening a discussion upon such a subject as that of soil analysis. The question is one upon which there has been perhaps more controversy than in any other branch of agricultural chemistry. Reviewing the long line of distinguished workers whose views have been upset time after time, Liebig, Ville and Leew, to mention only three, an attempt even properly to review the subject is quite beyond my powers.

The fact must be faced, however, that, in spite of the numerous failures that have occurred, the band of workers upon pure chemical soil investigation is still increased, and that we still seem to have a hope of evolving order out of the chaotic mass of contrary opinions, each based apparently upon actual observations and upheld by their authors with grim determination.

Only recently we read of a discussion (*Nature*, December 30th, 1920, page 582) between chemists and botanists at the meeting of the British Association at which it was resolved—

(1) That soil chemists were quite agreed that the time had come for a revision of the methods of soil sampling and analysis at present in use, and it was felt that it was not desirable to embark on any extensive new work before it was done.

(2) It was evident that there was need for a much closer co-operation between the soil chemist and the plant ecologist both in planning survey work and in carrying it out. In other words, in spite of the vast amount of work that has been done on the soil from many points of view, it has been conceded that something more is needed if progress is to be real.

The secret of the difficulty would appear to lie in the diversity of problems which are approached by the soil chemist, which cannot be solved by one general standardized method. These problems may be grouped under two broad heads :—

(a) The comparison of soils with a view to introduction of new crops.

(b) Improvements of soils with a view to obtaining increased yields of crops already grown.

It has long been known that a mere ultimate chemical analysis will give little or no indication of the type of soil suitable for a special crop. The realization of this fact led to the extreme view advocated by Whitney and his co-workers, the universal application of which has been contested by many well-known soil chemists, notably by Hall and others in recent years.

This view was to all intents and purposes that the great majority of cultivable soils were so similar in composition that the soil water solution was practically the same in all. In consequence he maintained that the only analysis that really gave reliable information, of the probable action of soil towards special crops, was the mechanical analysis. He admitted that, in special cases, a chemical analysis might be of use, but he maintained that these cases were special. The majority of his work was connected with the organization of the American Soil Survey. There seems to be little doubt of the value of this method when used merely for comparison of soils with a view to the introduction of new crops. Its worth in fact appears to have been proved in some cases by the successful introduction of crops, notably of improved varieties of tobacco, into districts where they were not grown before.

Had this school of analysts stopped here, it would have been difficult to contest their final opinions, even though some exception might be taken to some of their promises. Difficulties arise however when we apply their theories to the second lines of investigation, that of the improvement of soils with a view to obtaining increased yields of crops already grown. The Whitney hypothesis when carried to its logical conclusion demands the acknowledgment of the postulate that the old theories of nutrition by fertilizers were entirely wrong. This school brought forward the theory that fertilizers were merely antidotes to specific toxins secreted by special crops and that their functions were therefore those of antiseptics and not of nutrients. The acceptance of this theory carried to its logical conclusion would apparently demand the rejection of chemical analysis as means of detecting fertilizer-requirements of a crop. This view has been vigorously contested by chemists both in and outside America, notably by Hall, Branchley and Underwood in a paper published by them in 1913 (reprint in *Journal of Agricultural Science*, 1914, from *Philosophical Transactions*, 1913, B 204). The net result of their investigations is to restore the earlier theory of the direct nutrition of the plant by fertilizers. The conclusion drawn by these investigators were of such importance that it will be of interest to refer to them in full,

These conclusions were :—

(1) The composition of the natural soil solution as regards phosphoric acid and potash is not constant, but varies significantly in accord with the composition of the soil and its past manurial history.

(2) Within wide limits the rate of growth of a plant varies with the connection of the nutritive solution, irrespective of the total amount of plant food available.

(3) When other conditions, such as the supply of nitrogen, water and air, are equal, the growth of the crop will be determined by the concentration of the soil solution in phosphoric acid and potash which, in its turn, is determined by the amount of these substances in the soil, their state of combination and the fertilizer supplied.

(4) On normal cultivated soils, the growth of crops like wheat and barley, even when repeated for 60 years in succession, does not leave behind in the soil specific toxic substances which have an injurious effect upon the growth of the same or other plants in that soil.

These conclusions are more interesting in that Hall and Russell in 1911 stated that up to a certain point they agreed with Whitney although they pointed out certain cases in which his methods were not likely to be workable. It will be observed that the opinions expressed above are general statements which, as it were, outline the policy that should be followed by soil analysts in determining the requirements of crops. No hard and fast rule is laid down as to methods of obtaining the soil solution, but the fact is laid down that there is every hope for the soil analyst when he commences to investigate his soil. Moreover, it indicates that the immense amount of routine work done by investigators before Whitney and Cameron has not been without value. On the other hand, the necessity of such a detailed proof of what was formerly regarded as an axiom, should impress upon all soil workers that they should refrain from dogma.

The investigation of soil phenomena by the chemist may be likened to the science of medicine. It deals with a multiple of complicated phenomena each hinged upon the other, and each case must be diagnosed separately and treated on its merits. To condemn a method of analysis, because it does not give positive indications in every case, is on a par with the condemnation of the medical profession because it may be possible to diagnose two different kinds of fever from the same symptoms, while the patient may be suffering from a third and unknown complaint. We are merely on the fringe of soil investigation, and the interpretation of results of analysis, as diagnoses in medicine, depends to a very great extent upon the observer.

The soil problem may be tackled from numerous points of view, biological, physical and chemical, but the main object will be the same, to increase the crops of the country. This may be done both by introducing new crops and by increasing the present crops both by cultivation and by the application of special fertilizers. It is in this last case that there is the greatest hope of progress and the line in which the greatest progress can be made would appear to lie in the development of methods for the determination of the needs of the plant as regards fertilizers in soils of different chemical types. Attempts have been made to advance in this direction for the last thirty years, since Dyer introduced his famous method, which has in many cases given reliable indications of plant requirements, although the assumptions upon which it was based were most probably incorrect.

It is nearly impossible to lay down any special direction in which progress is not necessary in soil analysis, but this study of special subjects, such as the soil solution, has certainly given definite results in the past and is giving sufficiently interesting and useful results at the present time to warrant a further study. To take another case of a study in which such a special point has been taken, I may mention the work^[1] by Harrison and others upon the gases in swamp rice soils. A systematic observation of a few factors only has led the authors to formulate certain theories which are likely to be of great value in their application.

I have indicated above the main lines upon which soil analysis has been carried on in the past, and one at any rate which is likely to be of value. It would appear from a consideration of the recent opinions of soil investigators that progress is necessary in every direction, but I would suggest that in India, at any rate, lines of investigation in which attempts are made to determine the fertilizer-requirements of soils are likely to be of profit than any other. Hall and his co-workers appear definitely to have disproved the theory that the fertilizer was not plant food, and this has been a step in the right direction. We are still, however, very much in the dark as to the reasons for the different action of fertilizers in soils which give no chemical indication of the cause of these differences.

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